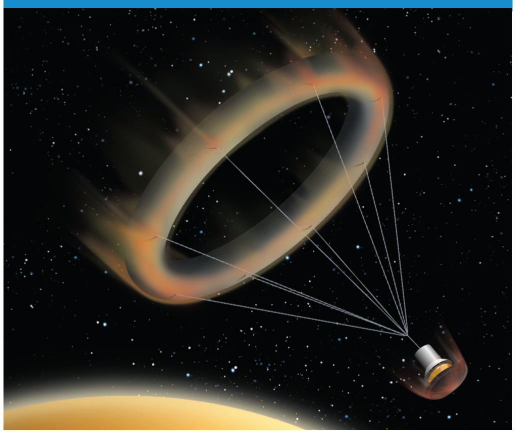
National Aeronautics and Space Administration

Materials Characterization

MISSE-6 Materials Selection

NASA Marshall Space Flight Center



It is important to understand materials' behaviors in the environments where they will operate. No simulator on Earth can duplicate the combined effects of the space environment: radiation, micrometeoroids, space vacuum, and thermal cycling. The Materials on International Space Station Experiment (MISSE) allows researchers to place materials in suitcase-size containers outside the International Space Station (ISS) and to study their response to space environment exposure. Spacecraft designers use these data to select materials that are durable. To provide access to information on numerous materials, industry, academia, and government agencies collaborate to develop the MISSE experiments. For past MISSE experiments, researchers at NASA's Marshall Space Flight Center (MSFC) have selected materials that will be useful for diverse applications such as launch vehicles, lunar spacecraft, and space telescopes.

Task Description

Based on the results from previous experiments (MISSE-1 and -2) recently returned to Earth in August 2005, MSFC materials scientists are designing a module for the sixth mission (MISSE-6) to carry samples that will be useful for advanced exploration craft.

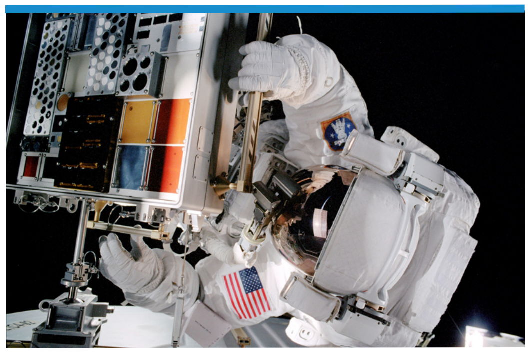
Tasks include

1. Identifying and fabricating candidate materials
2. Testing materials in simulated space environments and for flight qualification
3. Designing a sample carrier and loading samples
4. Performing thermal vacuum bakeout of loaded samples
5. Delivering flight hardware for integration into the MISSE-6 payload.

This 10-month task will be completed in September 2006.

Anticipated Results

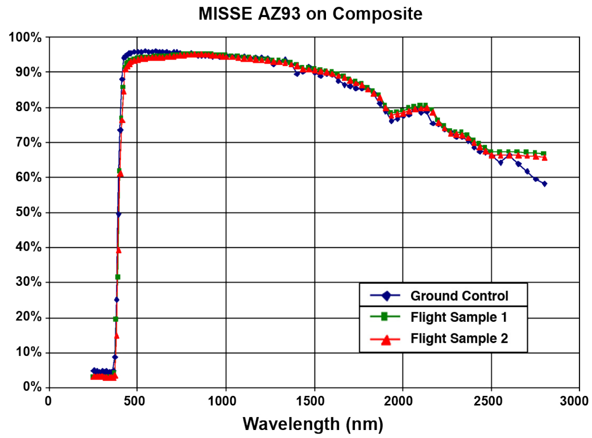
Inflatable ballutes – large structures that combine the traits of balloons and parachutes – are being designed to slow down payloads returning to Earth from the Moon and for missions landing on other planets and their moons. (See artist concept, top left.) Based on MISSE-1 and -2 materials performance, this Advanced Materials for Exploration (AME)



Astronauts attached the suitcase-size Materials International Space Station Experiments (upper left) to the ISS Quest airlock and exposed 750 material samples to the space environment for 4 years. In August 2005, the STS-114 mission returned MISSE-1 and -2. MISSE-5 has been deployed on the ISS since August 2005, and MISSE-3 and -4 are slated for delivery to the ISS during the STS-121 mission scheduled for July 2006.

advanced materials for exploration

MISSE-6 MATERIALS SELECTION



This reflectance data was collected by testing a materials sample composed of a white thermal control coating (AZ93) applied to a high-temperature cyanate ester composite substrate. The data show that even after 4 years in space, the thermal coating was stable. The coated composite, which was part of the MISSE experiment attached to the outside of the International Space Station, could be used to coat space vehicle radiators. Most thermal coatings have been tested on aluminum substrates. This was one of the first experiments to demonstrate that a coating would adhere to a composite substrate and not degrade substantially when exposed to the harsh space environment.

team recommends flying scale models of ballutes made of lightweight yet strong, high-temperature, flexible polymer films. The ballute models will be packed as if for deployment in a 15.24-cm x 15.24-cm x 3.18-cm (6-in. x 6-in. x 1.25-in.) module being designed and flight qualified by the team. The module will be thin enough to allow maximum radiation, hard vacuum exposure, and temperature variation.

The top of this module will be loaded with rip-stop fabrics and wire materials used to tow spacecraft and equipment and tethers that can propel spacecraft by harnessing electrodynamic energy. Based on prior tests and experience working with tether manufacturers, the Principal Investigator selected Spectra® and Zylon® tether materials for MISSE-6. Since tests have shown Zylon® to be very sensitive to ultraviolet (UV) radiation, a protective coating will be applied to some Zylon® tether samples so that environmental responses of coated and uncoated samples can be compared.

Solar sails use the Sun to power spacecraft and may allow more efficient deep space travel. MSFC scientists have exposed thin film sail materials to simulated space environments, including electrons, UV radiation, and meteoroid/debris impact. Based on these tests and recommendations from thin film manufacturers, materials will be selected and loaded into special compartments outfitted with UV-grade windows that prevent exposure to atomic oxygen. Atomic oxygen is abundant in low-Earth orbit where the ISS is located and can erode these materials, but it will not be present in deep space where the sails will mostly operate.

Relevant to the Crew Exploration Vehicle development is the testing of candidate thermal protection materials. These materials include ceramic matrix composites and ablatives that may be used in heat shields. Multipurpose materials also may provide shielding from harmful radiation. Some of these materials have been exposed to space environment conditions in simulators at the MSFC Materials and Processes Laboratory; these test results will be compared with effects observed during MISSE-6.

Potential Future Activities

These MISSE experiments give MSFC the opportunity to flight test materials needed for exploration programs, such as the Crew Launch Vehicle, the Crew Exploration Vehicle, the Robotic Lunar Exploration Program, and the James Webb Space Telescope. Postflight activities will focus on analyzing the MISSE-6 samples; data on materials performance will be placed in the Materials and Processes Technical Information System (MAPTIS) databases, which are accessible to spacecraft designers.

Capability Readiness Level (CRL)

This AME flight experiment will increase the CRL level of all the tested materials to CRL 7.

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